Generation and Evaluation of Long-Term Forecasts with NCEP CFS: A Progress Report

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<u>Outline</u>

- Background and Objectives

- Experiments and findings

- Other Relevant Progress

Motivation

- An outstanding problem in climate prediction is the lack of long enough experiments of retrospective forecasts to assess model skill, to identify model deficiencies and, more generally, to study climate variability and predictability on various timescales.

- Most of existing experiments of this sort only cover the last 10-30 years, with degrees of freedom too few even for interannual fluctuations such as ENSO.

- Thus it is desirable to extend such experiments all the way to the mid-19th century, when instrumental in-situ observations first became available.

Feasibility (1)

(1) Main obstacle: limitation of historical data for model initialization.

(2) Nevertheless, it has been demonstrated with an intermediate ENSO forecast system that, with a coupled initialization strategy using SST and SLP, skillful long-term retrospective forecasts are feasible using the available datasets.

(3) The procedure for the intermediate coupled model should be applicable to advanced CGCM systems such as CFS.
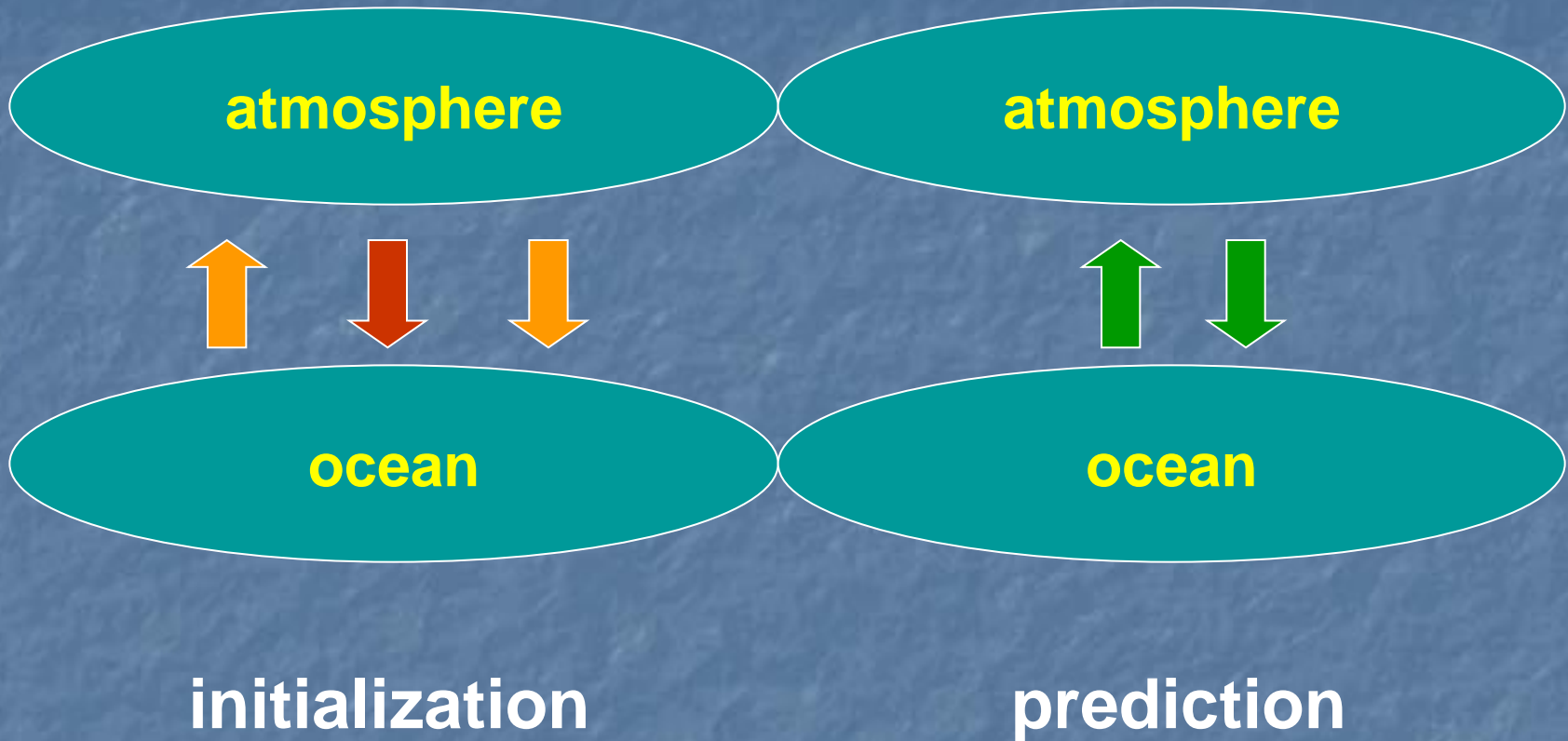
Feasibility (2)
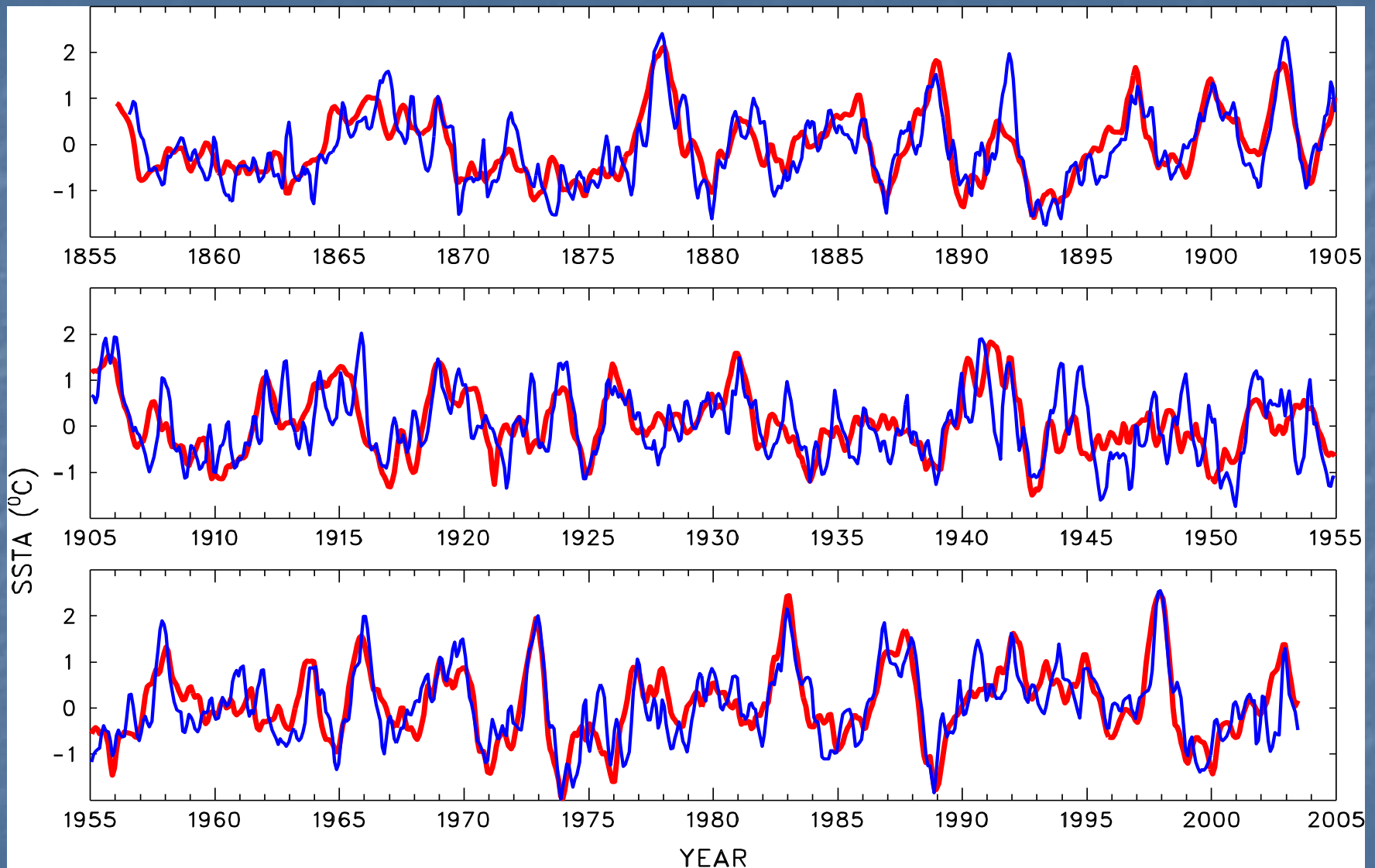
OBSEREVD AND PREDICTED NINO3.4 SSTA

Chen et al., *Nature*, 2004

Hypothesis

(1) The CFS can be well initialized in a coupled manner by assimilating only SST data over the past one and a half centuries.

(2) The coupled initialization run and the subsequent retrospective forecasts are realistic enough (at least) for ENSO and drought studies.

CDA vs. ODA

(1)   Coupled data assimilation (CDA): A/O Consistent with SST; Smoother forecast starts; Same model for initialization and prediction.
(2)   CFS v1: Realistic initial states (GODAS and R2); not necessarily the optimal; "initialization shock"

Wang et al., *Mon. Wea. Rev.,* 2005
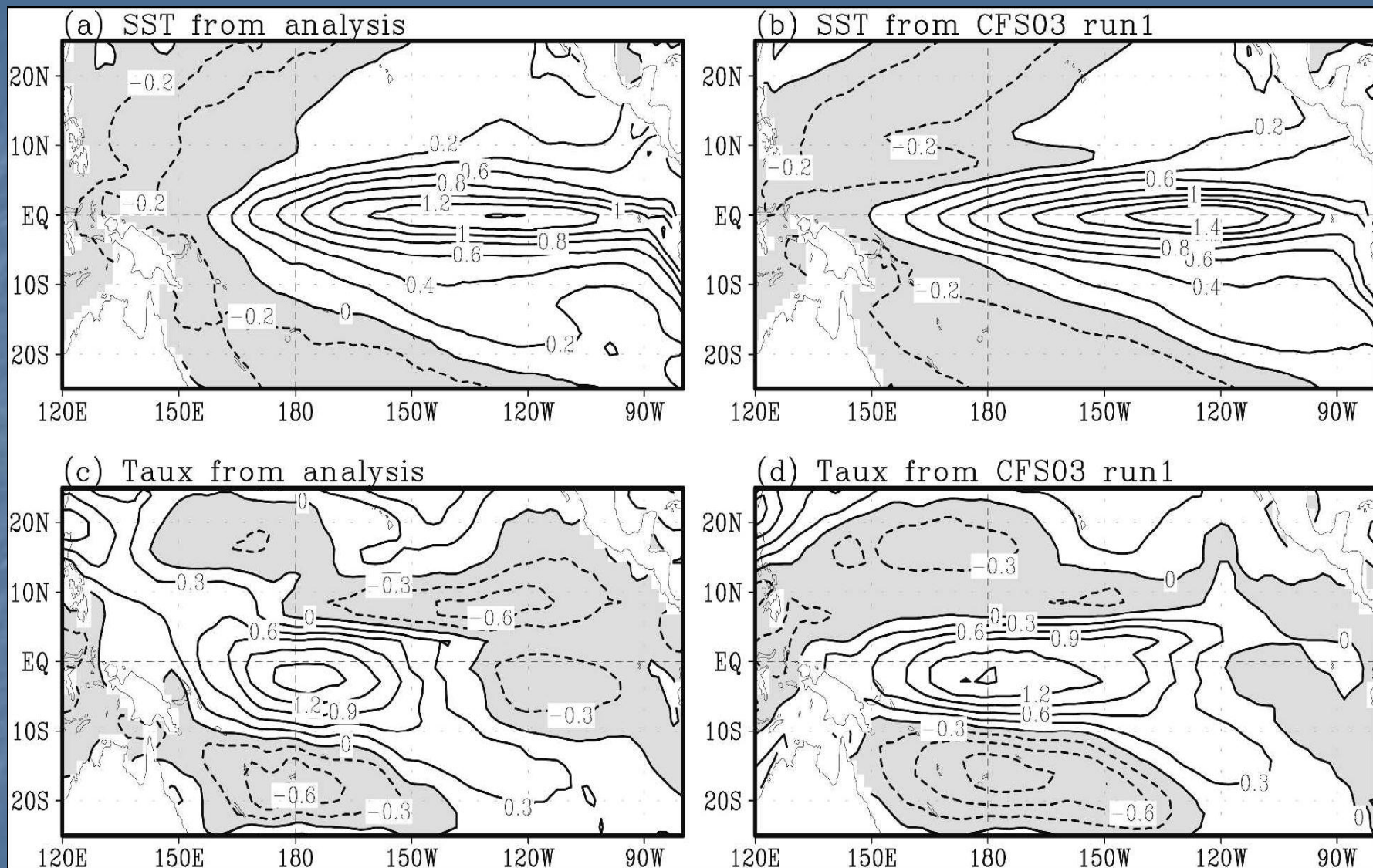
Objectives

- Develop coupled data assimilation and model initialization procedure for the CFS;

- Generate retrospective forecasts for the past one and a half centuries with the CFS;

- Evaluate the predictability of ENSO and drought using the resulting datasets.

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Testing CDA procedure for the CFS

Equatorial anomalous heat content (0-300m)
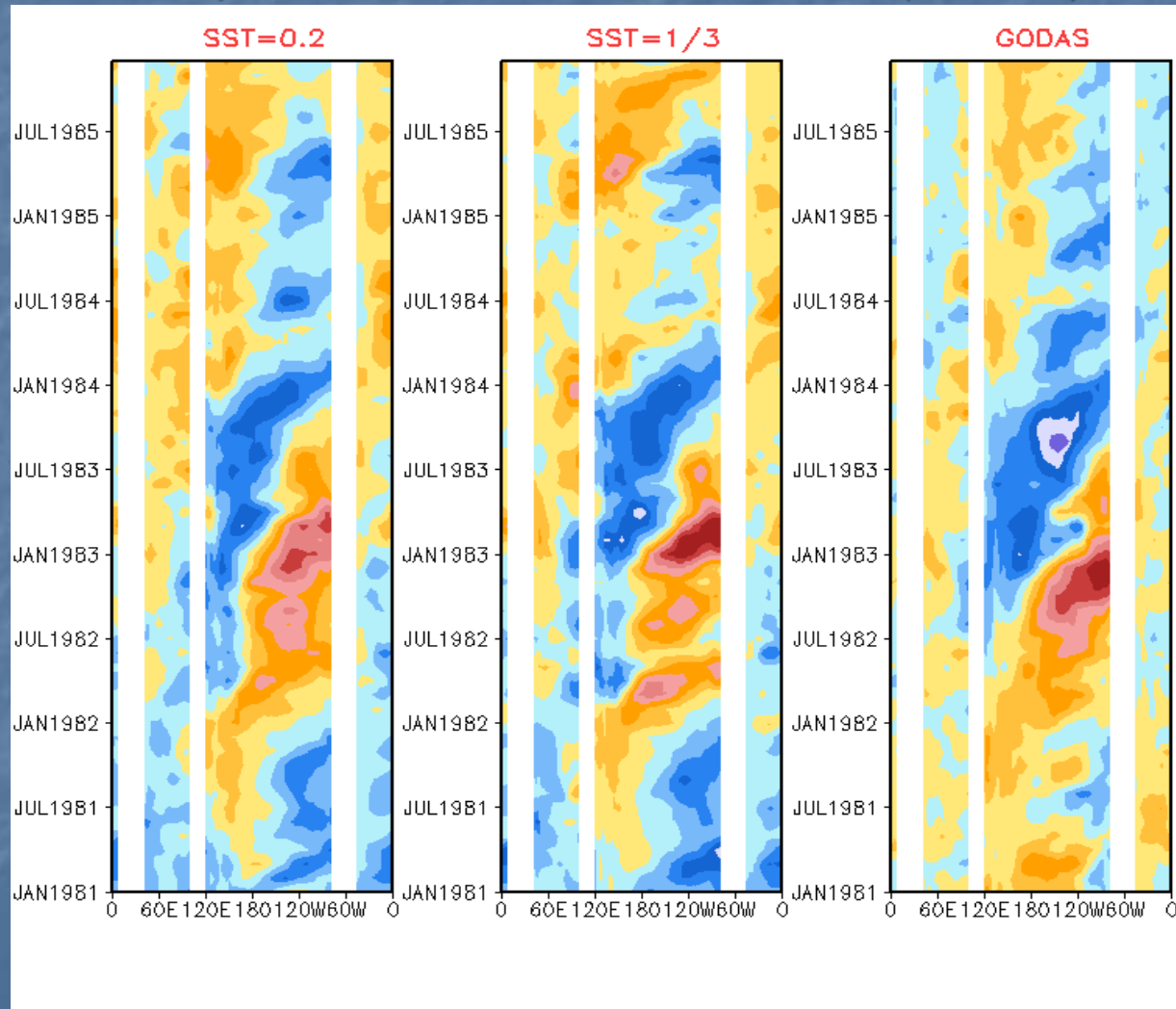
Constructing 150-year CFS control run with CDA

Global mean T2m
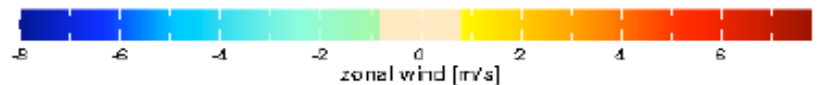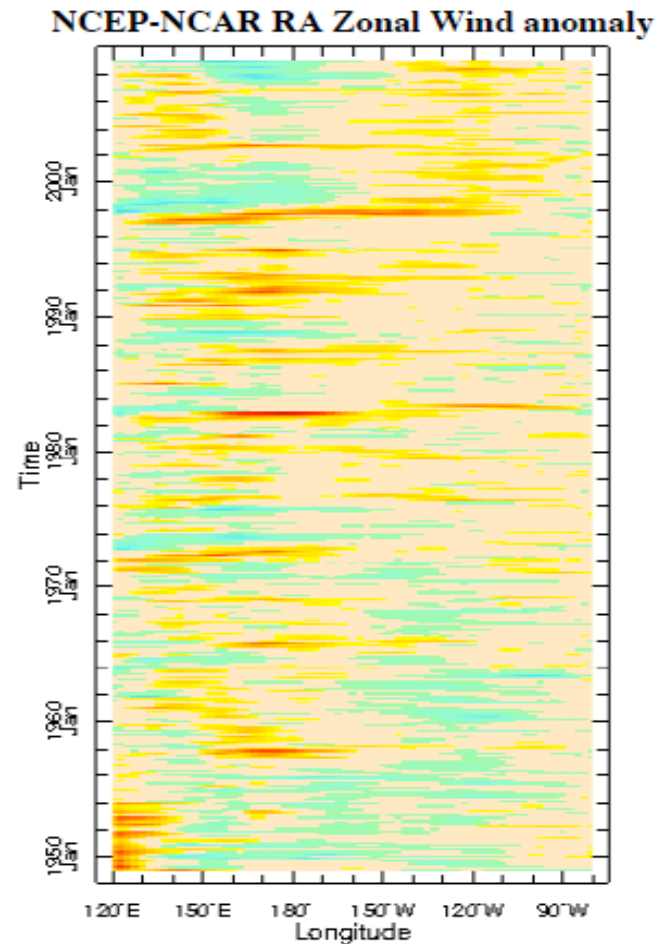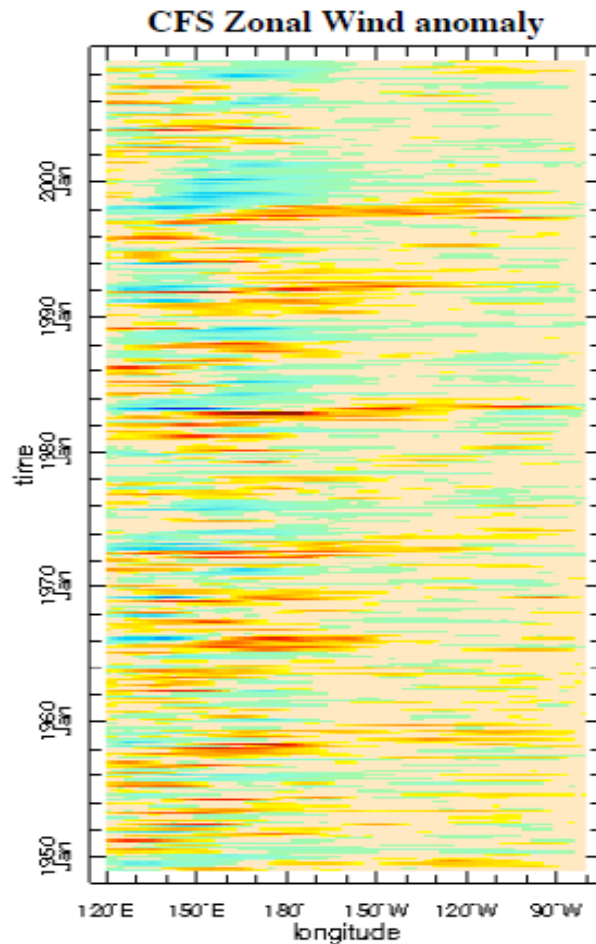

Global mean precipitation
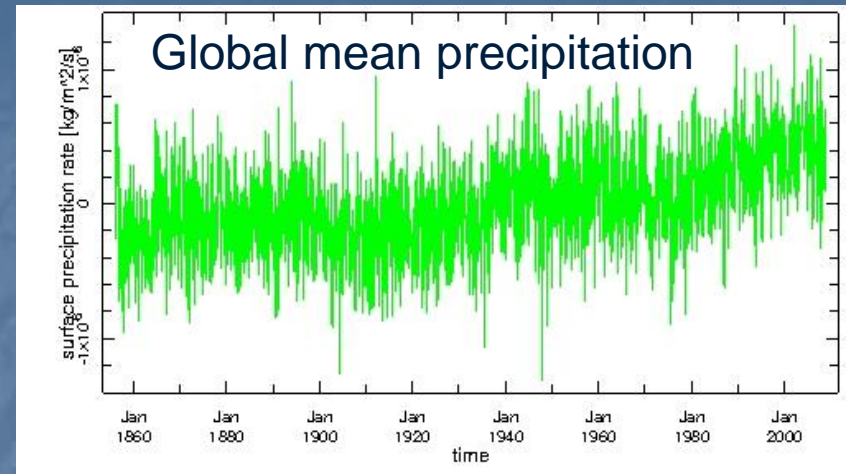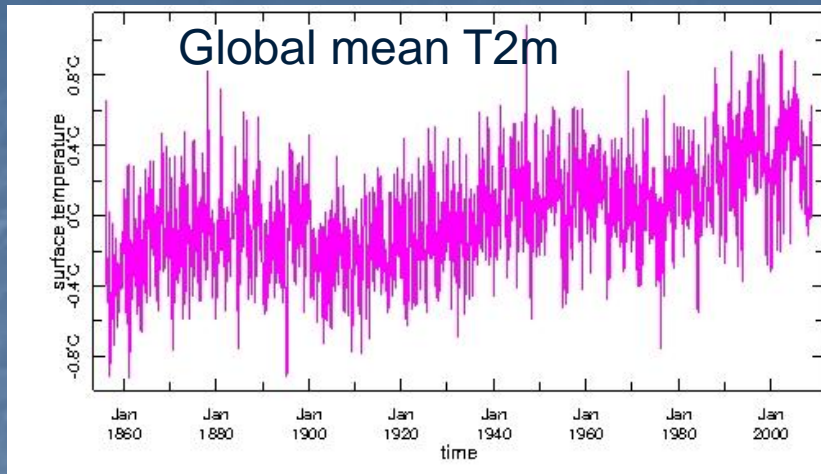
T2m standard deviation
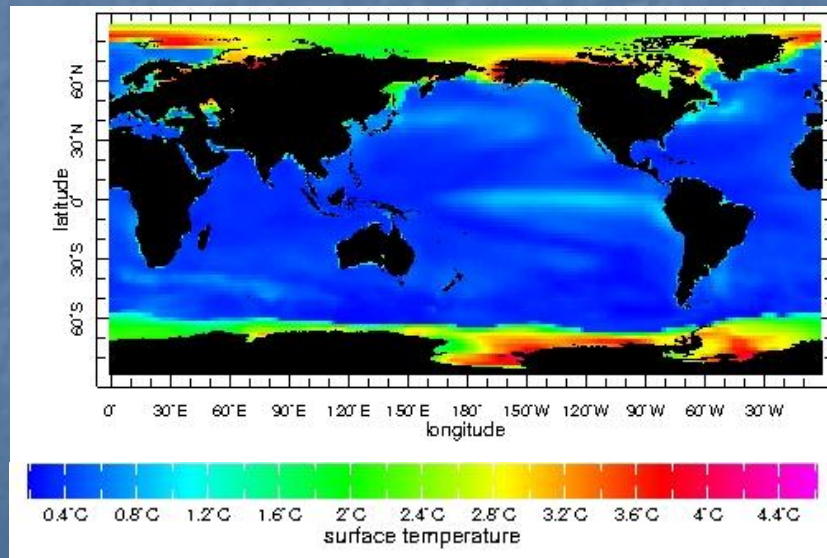
Precipitation standard deviation

http://kage.ldeo.columbia.edu:81/home/.OTHER/.gus/.cdfs/.NCEP/.CFS/.nc/
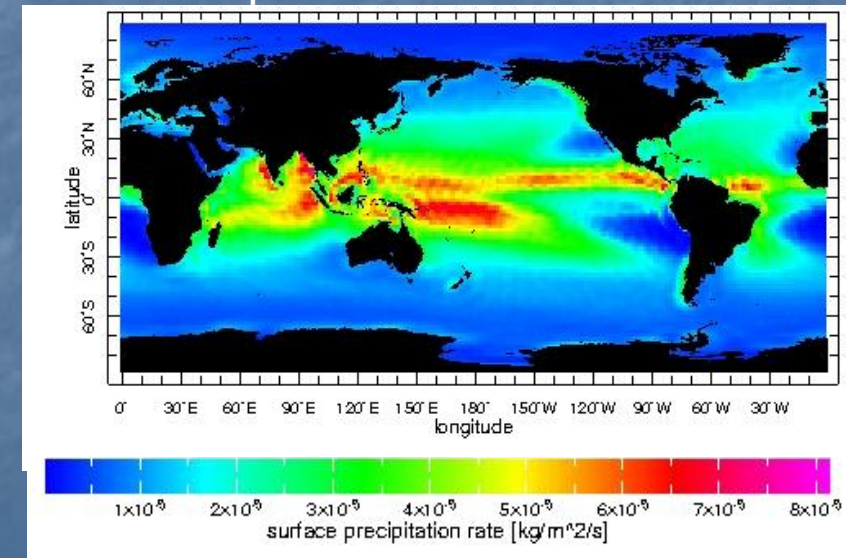
Sea Level Anomaly (SLA), cm
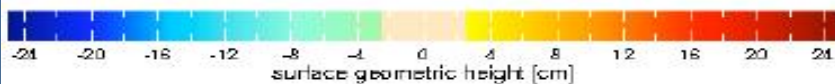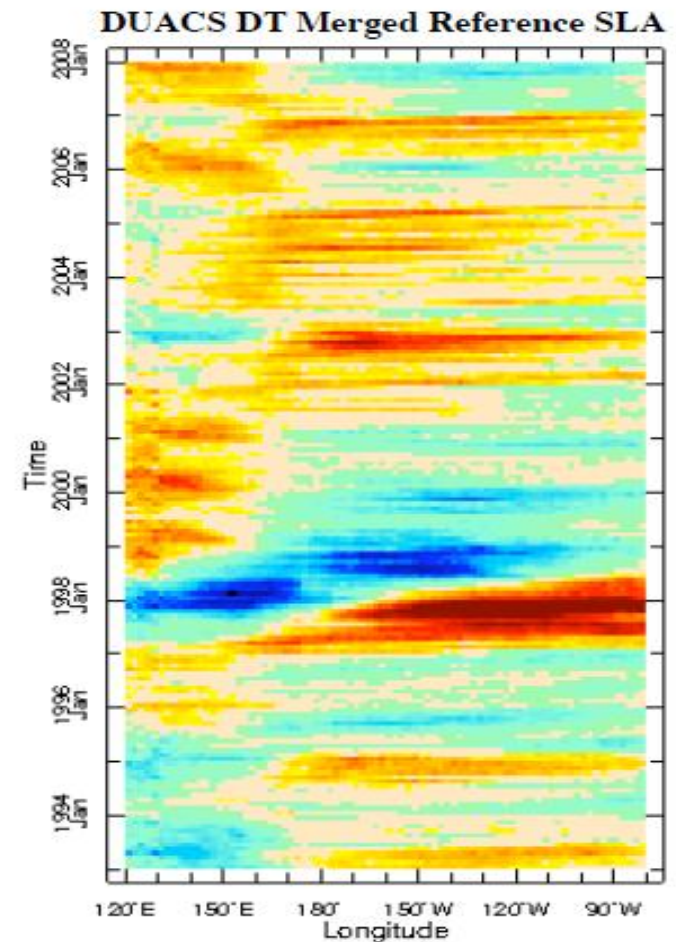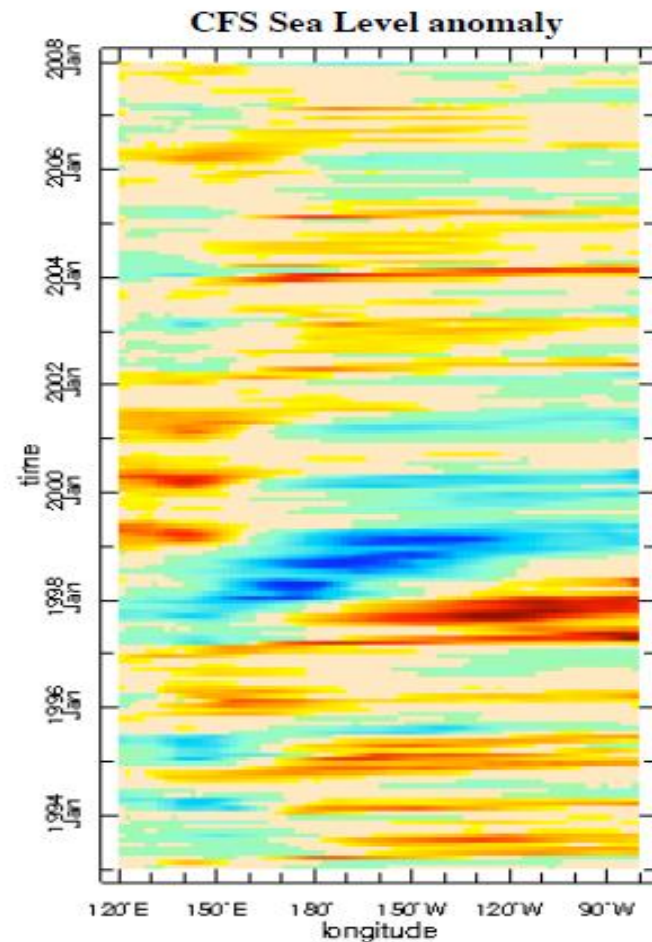
Comparison of CFS CDA run with NCEP R1: 1949-2008

10m Zonal Wind, m/s

150-year CFS retrospective forecasts:
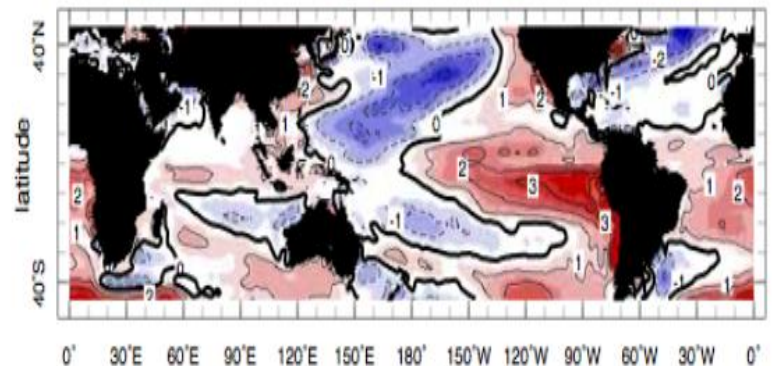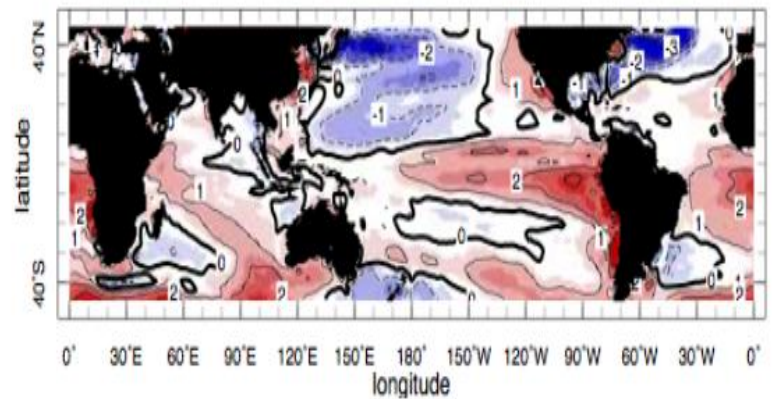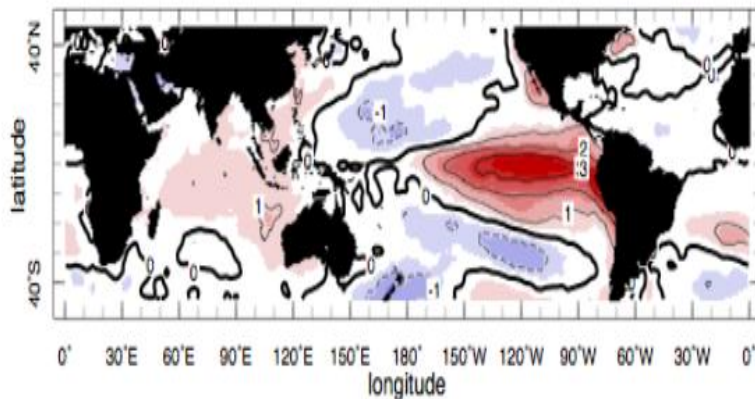## Large El Nino events
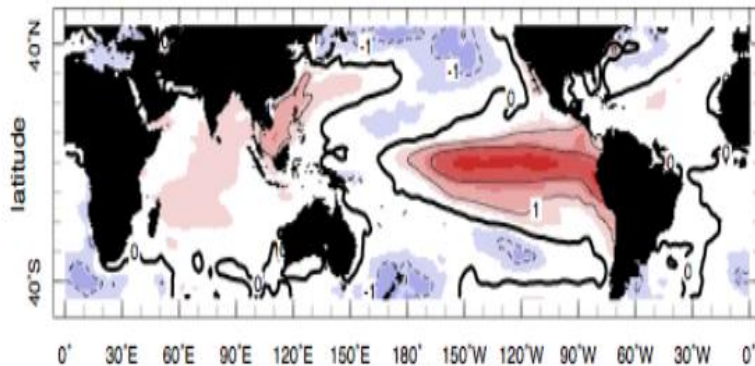
150-year CFS retrospective forecasts:
## SW US precipitation and surface temperature
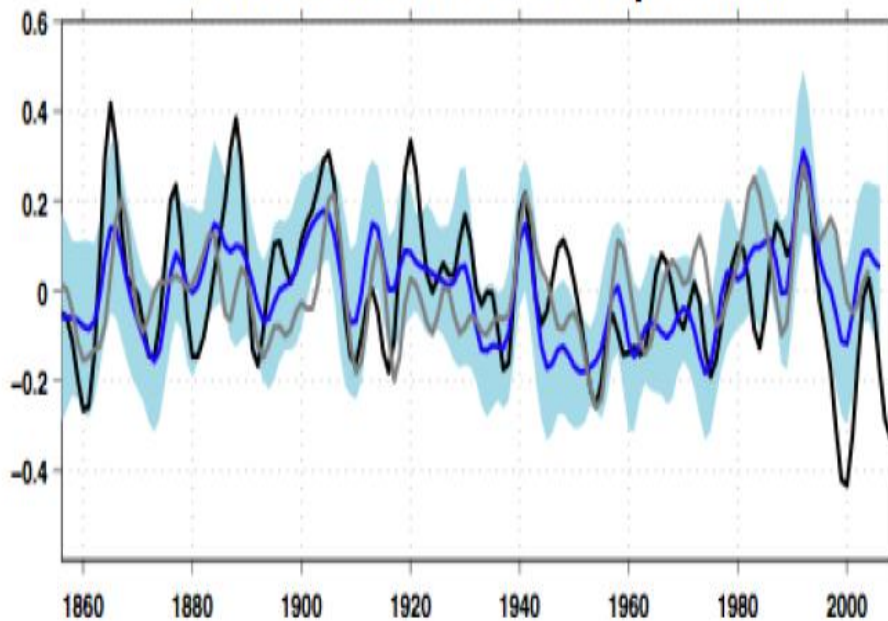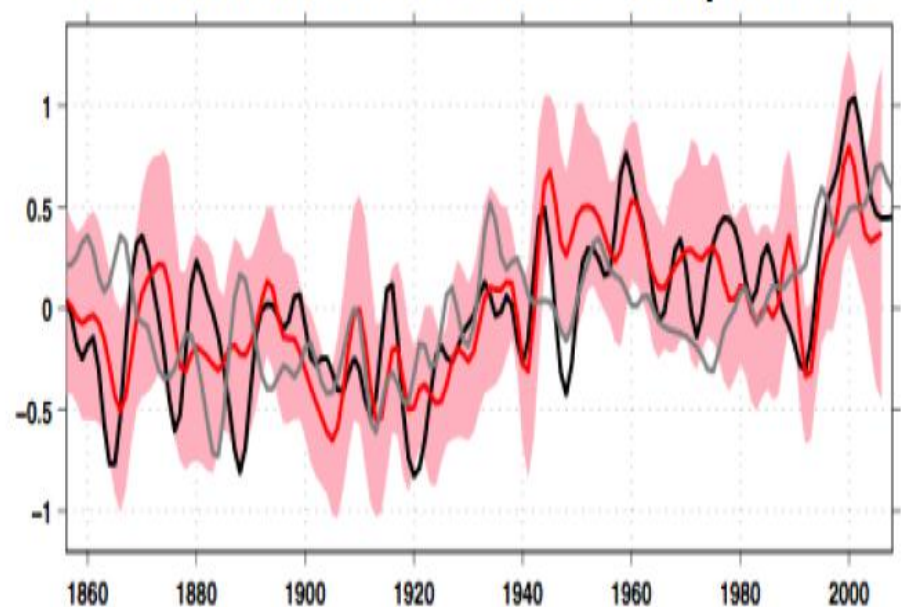
Findings

- Historic ENSO events are properly represented in the 150-year "coupled reanalysis";

- The CFS is able to capture some of the variations in precipitation and temperature over the southwestern US by assimilating only SST;

- Forecast runs are able to predict large El Niño events, including those in the 19th century;

- There are systematic model biases, especially at high latitudes, which may not be overly prohibitive for our purpose but need to be corrected for further improvement.

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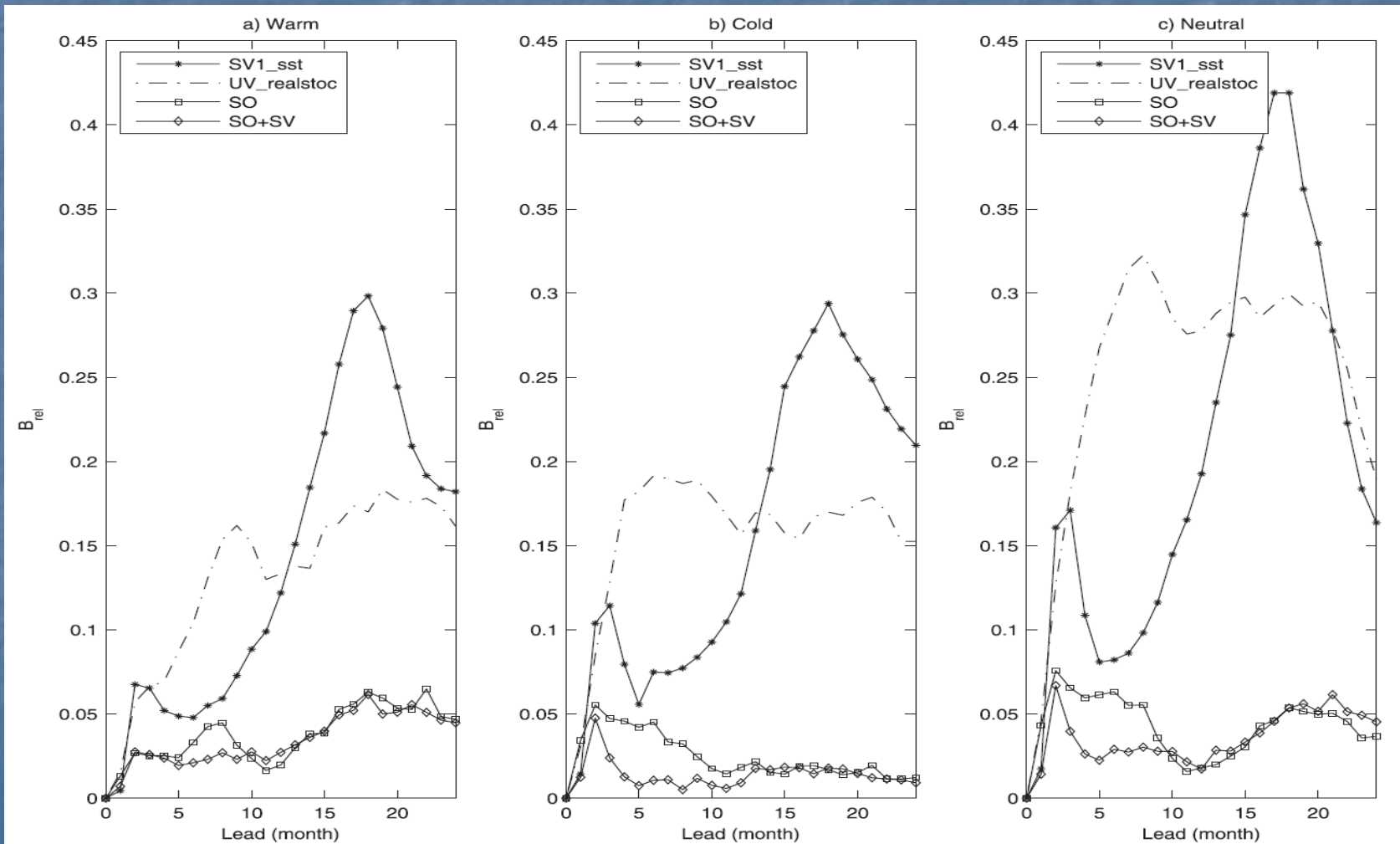- Experiments and findings

- Other relevant progress

Linear multi-model ensemble predictions of the tropical Indo-Pacific SST

Wu and Chen, GRL, 2010
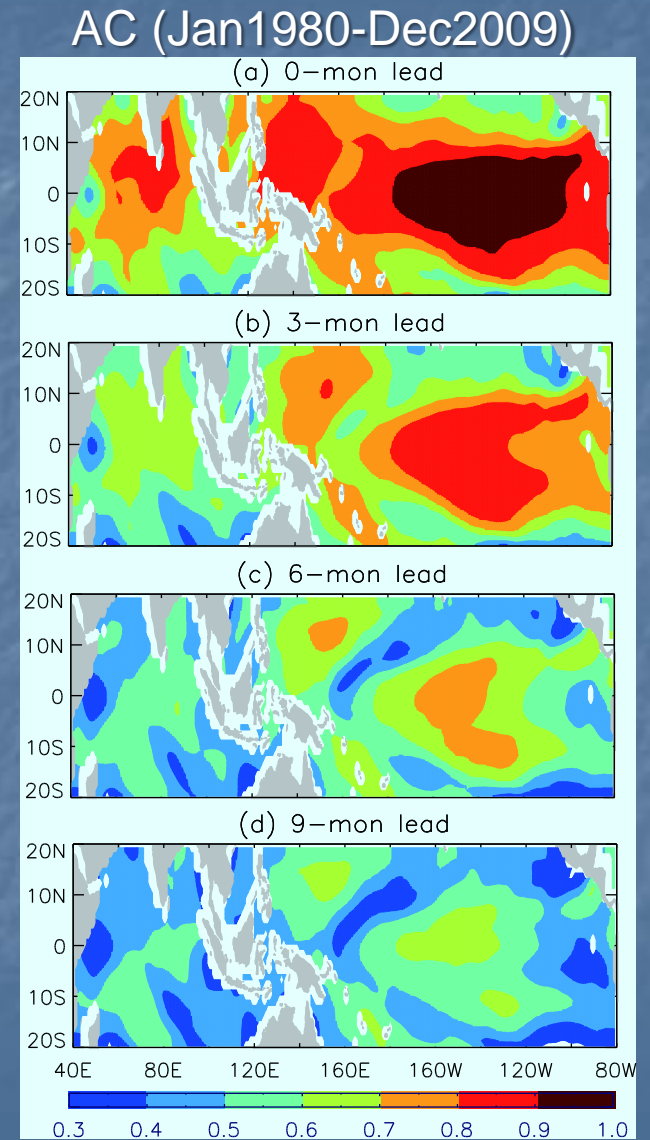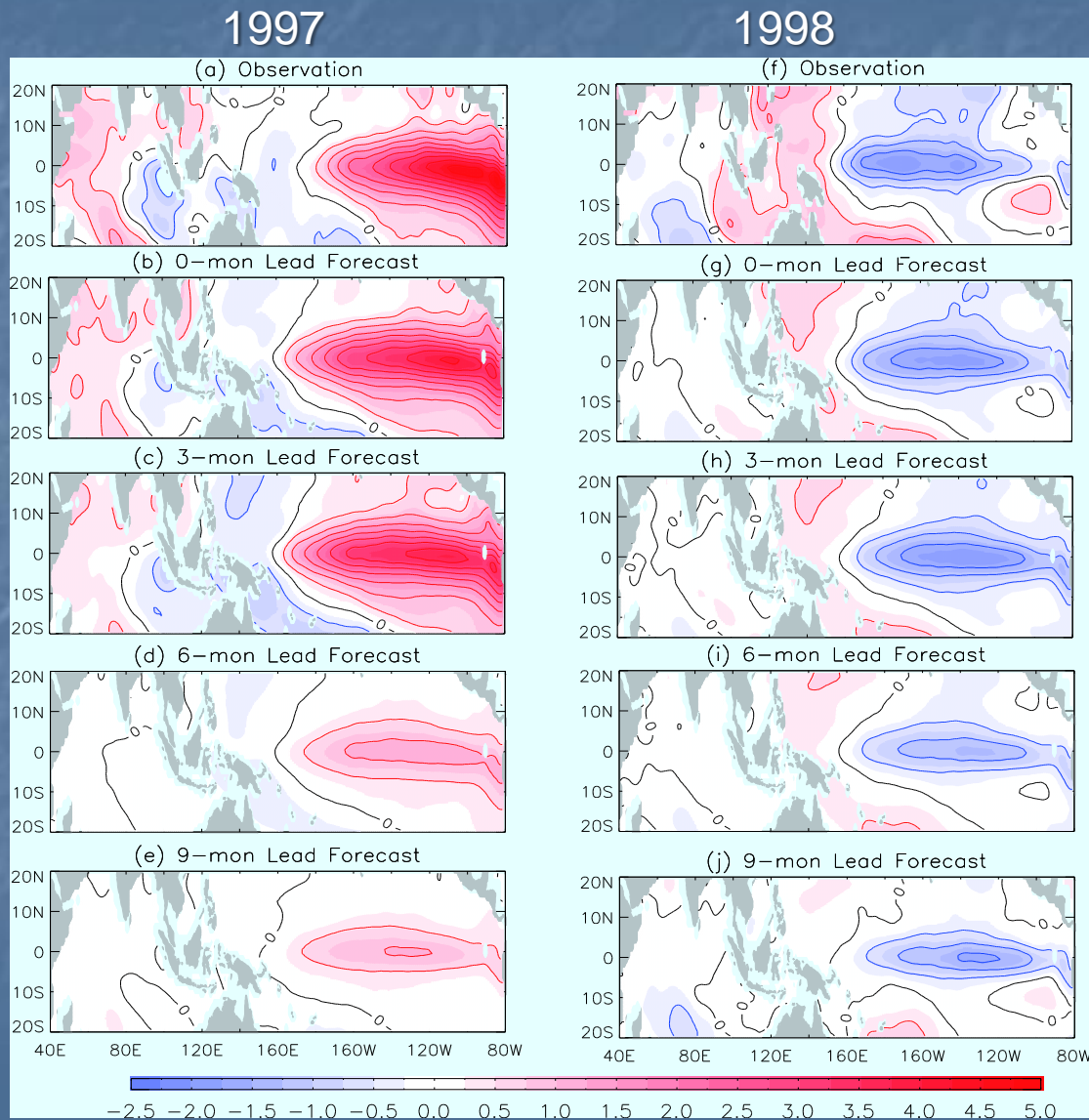
Methodologies of ensemble construction for probabilistic ENSO prediction

SV1_SST: SST perturbations   SO: Stochastic optimal H-F winds
UV_Realistic: Observed H-F winds   SO+SV: SO+SV

LDEO5 model   Brier Score   **Cheng et al., *JC*, 2010**

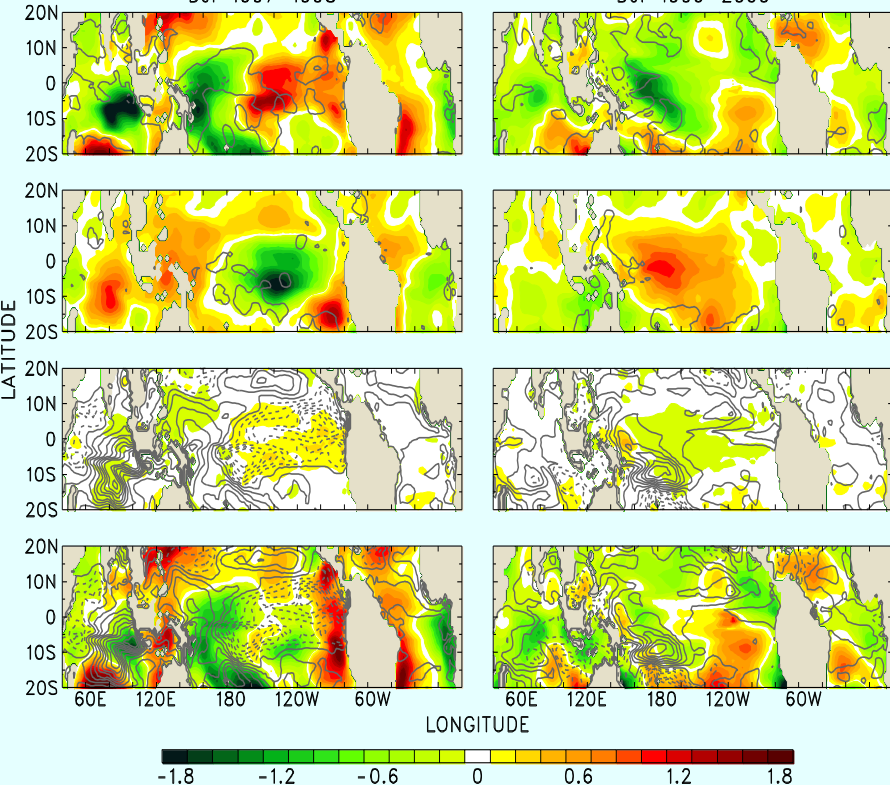# The effects of the surface heat and freshwater flux anomalies on tropical ocean simulation

Surface

5S-5N average
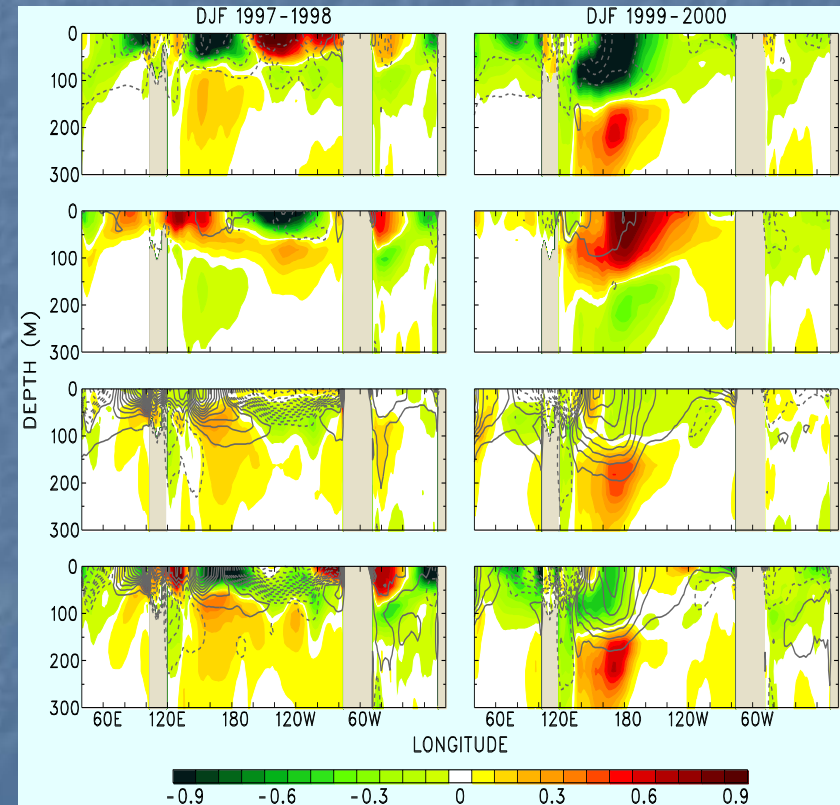
Shadings: Temperature; Contours: Salinity

Chen and Cane, *JCP*, 2008

Indo-Pacific Tripole: an intrinsic mode of Tropical climate variability
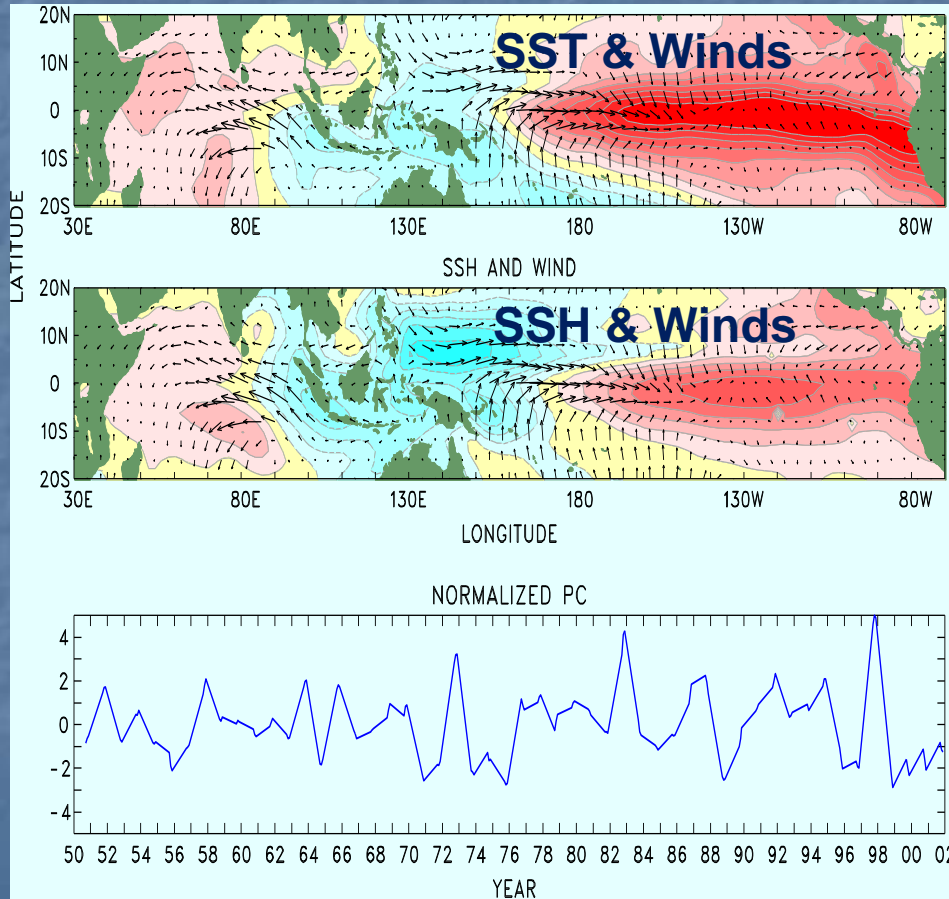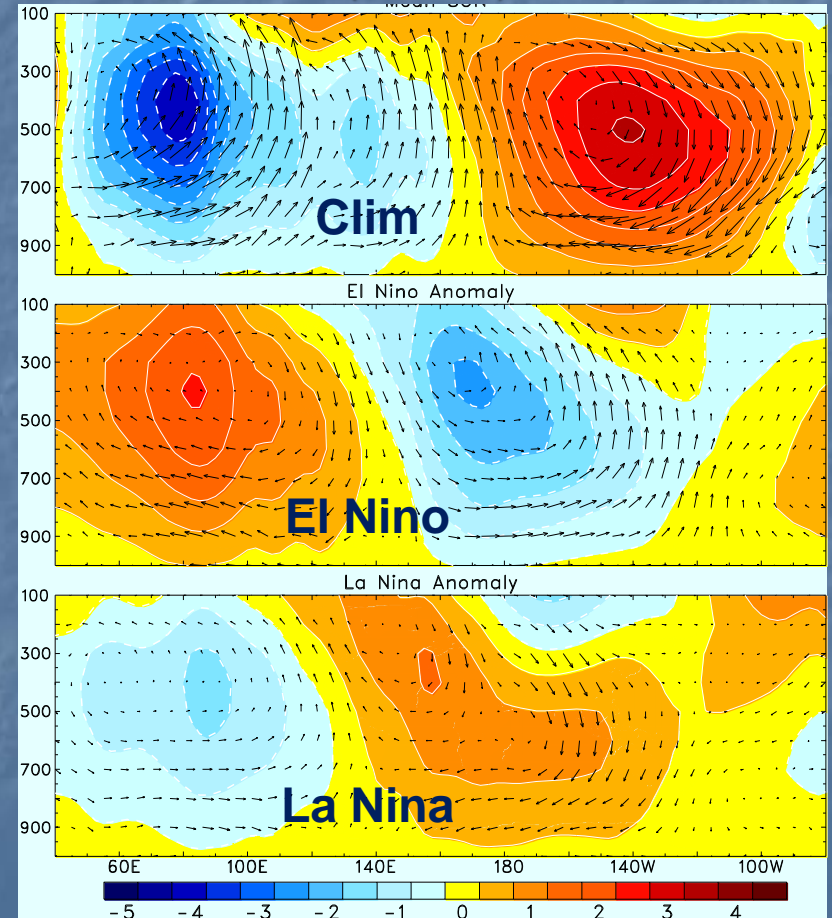
Chen, *AG*, 2011; Chen and Cane, *JCP*, 2008

Thank You